Heat pump in a metro station
RATP (Paris)

CONCEPT

RATP installed a heat pump in the newly built metro station "Front Populaire", following the extension of metro line 12. The heat pump is intended to heat and cool the air of the underground staff and technical rooms by taking the air outside of the station. When the outside temperature is between -5°C and 19°C, it is used to heat the rooms; when the temperature is higher than 24°C, it cools the rooms. This investment enabled RATP to run for the first time a heat pump in a metro station.

SUPPLIER

Heat pump:
CLIMAVENETA, NECS/302/LN

Feasibility study : **CEGELEC**

Technical Data	
Cooling power	73.2 kW
Thermal power	83.6 kW
Coefficient of performance	3.22

OBJECTIVES

- Guarantee a convenient temperature in underground staff offices;
- Ensure the temperature is kept at a certain level in the technical rooms to prevent any damage to the equipment;
- Improve the energy efficiency of underground staff offices and technical rooms.

INVESTMENT DESCRIPTION

The new metro station "Front Populaire" was built in the framework of the extension of the metro line 12 to the North of Paris and was inaugurated in December 2012. This underground station is located in the groundwater. It has a surface of 7,500 m^2 (4,500 m^2 of technical rooms and 3,000 m^2 for passenger facilities) and it is built on four levels. The investment consists in implementing a water/air heat pump to heat and cool technical rooms and station offices. In the physical world, heat is transferred from the warmest location to the coldest location (entropy phenomenon). A heat pump reverses this process, in the same way as refrigerators. The installation comprises one air/water heat pump and two air treatment units. The heat pump is electrically powered and takes air from outside and rejects either cold or warm water in order to feed the batteries of the air treatment units. The air was supposed to be extracted from the space between the wall lining and the wall. Due to technical constraints, the air is now extracted from outside of the station.

When the outside temperature is between -5°C and 19°C, the heat pump produces hot water to feed the air treatment units. The air blown inside the rooms reaches 22°c. This allows to renew the inside air of the technical rooms and staff offices but not to ensure a sufficient temperature in the staff offices. As a result, manual electrical heaters are available to compensate the heating requirements. As a result, it is important to educate users to use the system so that they adjust the electric heaters in an appropriate way. Between 0°C and 19°C, the coefficient of performance is 4 (for 1 KWh consumed, the heat pump produces 4kWh). Between -5°C and 0°C, the heat pump uses a part of its heat production to prevent the freezing of the system. Between 19°C et 24°C, the heat pump is not used. The renewed air comes directly from air treatment units with no interaction with the heat pump. When the temperature goes over 24°C the heat pump is used to cool the rooms. The heat pump produces cold water to feed the batteries of the air treatment units which blow fresh air at a temperature of 19°C in the rooms.

Results	
Investment costs (€)	€77,000
Annual cost savings (€/year)	€9,660/year
Payback time (years)	6 years

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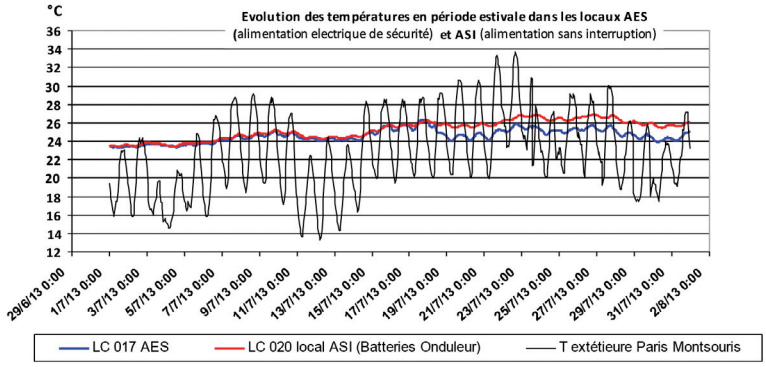
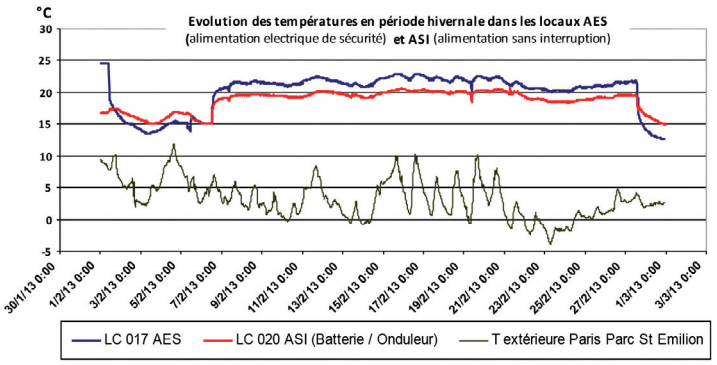
COST AND FUNDING

The cost of the system is €77,000 and the expected payback time is 6 years considering an appropriate use of the electrical heaters in the staff offices.

RESULTS

The temperature in the technical rooms has to be maintained below 25°C to prevent any damage to the equipment. Following the installation of the heat pump, the temperature has been kept between 18°C and 27°C at all times, which globally meets the requirements. A temperature control system was implemented in the technical rooms to monitor the temperature evolution and the humidity level in real-time.





LESSONS LEARNED

This investment enabled RATP to implement a heat pump for the first time in a metro station. The implementation process was not easy as it was the first experience in this field and it appeared that the air had to be extracted from outside of the station whereas the initial design aimed at taking the air from the wall lining. This project also highlighted the fact that staff must be trained to use the system efficiently. The investment did not foresee temperature sensors in the staff rooms so that it was not possible to make temperature measurements. This element will be improved in future investments.

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